

1 CLAIMS:

2 1. A method of bonding solder balls to bond pads on a
3 substrate comprising:

4 contemporaneously retaining at least two solder balls over different
5 respective bond pads on a substrate in the absence of flux; and

6 with said balls so retained, exposing the balls to bonding
7 conditions effective to bond the balls with their associated bond pads.

8
9 2. The method of claim 1, wherein the exposing of the balls
10 comprises laser-bonding the balls.

11
12 3. A method of bonding solder balls to bond pads on a
13 substrate comprising:

14 placing at least portions of a plurality of solder balls within a
15 frame and in registered alignment with individual bond pads over a
16 substrate; and

17 while the ball portions are within the frame, exposing the balls
18 to bonding conditions effective to bond the balls with their associated
19 bond pads.

20
21 4. The method of bonding solder balls of claim 3, wherein said
22 placing comprises placing individual solder balls within individual holes
23 within the frame.

24

1 5. The method of bonding solder balls of claim 3, wherein said
2 placing comprises placing majority portions of individual solder balls
3 within individual holes within the frame.

4
5 6. The method of bonding solder balls of claim 3, wherein said
6 exposing comprises laser bonding the balls with their associated bond
7 pads.

8
9 7. The method of bonding solder balls of claim 3, wherein said
10 exposing comprises laser bonding the balls with their associated bond
11 pads by fixing the position of the frame and moving a laser beam
12 relative to the frame from ball-to-ball.

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14 8. The method of bonding solder balls of claim 3, wherein said
15 exposing comprises laser bonding the balls with their associated bond
16 pads by fixing the position of a laser beam and moving the frame
17 relative to the laser beam from ball-to-ball.

18
19 9. The method of bonding solder balls of claim 3 further
20 comprising moving the frame away from the substrate.

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22 10. The method of bonding solder balls of claim 3 further
23 comprising after the exposing of the balls, moving the frame away from
24 the substrate.

11. The method of bonding solder balls of claim 3, wherein:
said placing comprises placing individual solder balls within
individual holes within the frame; and

said exposing of the balls comprises reflowing the solder balls
while the balls are within their individual holes, and further comprising
after said reflowing removing the frame from around the reflowed balls.

12. The method of bonding solder balls of claim 3, wherein said
placing comprises placing said ball portions on fluxless bond pad
surfaces.

13. A method of bonding solder balls to bond pads on a
substrate comprising:

providing a frame having a plurality of holes sized to receive
individual solder balls;

delivering individual balls into the holes from over the frame;

placing the balls into registered alignment, while the balls are in
the holes, with a plurality of individual bond pads over a substrate; and

bonding the balls with their individual associated bond pads.

14. The method of claim 13, wherein the holes are sized to
receive a majority portion of an associated solder ball.

1 15. The method of claim 13, wherein the holes are sized to
2 receive a majority portion of only one associated solder ball.

3
4 16. The method of claim 13, wherein said delivering of the
5 individual balls comprises rolling at least one ball over a frame surface
6 until the one ball drops into an associated hole.

7
8 17. The method of claim 13, wherein said delivering of the
9 individual balls comprises rolling a plurality of balls over a frame
10 surface until individual balls drop into respective associated individual
11 holes.

12
13 18. The method of claim 13, wherein said placing of the balls
14 into registered alignment comprises moving the frame to proximate the
15 substrate before any of the balls are delivered into the holes.

16
17 19. The method of claim 13, wherein said placing of the balls
18 into registered alignment comprises moving the frame to proximate the
19 substrate before any of the balls are delivered into the holes; and

20 said delivering of the individual balls comprises rolling a plurality
21 of balls over a frame surface until individual balls drop into respective
22 associated individual holes.

1 20. The method of claim 13, wherein the bonding of the balls
2 comprises laser bonding the balls with their individual associated bond
3 pads.

4
5 21. The method of claim 13, wherein the bonding of the balls
6 comprises laser bonding the balls with their individual associated bond
7 pads by fixing the position of the frame and moving a laser beam
8 relative to the frame from ball-to-ball.

9
10 22. The method of claim 13, wherein the bonding of the balls
11 comprises laser bonding the balls with their individual associated bond
12 pads by fixing the position of a laser beam and moving the frame
13 relative to the laser beam from ball-to-ball to effectuate the bonding.

1 23. A method of bonding solder balls to bond pads on a
2 substrate comprising:

3 providing a frame having a plurality of holes;

4 inserting individual solder balls into the holes, the balls being
5 small enough to pass through the holes;

6 placing the frame into proximity with a substrate having bond
7 pads positioned thereon, more than one of the plurality of holes holding
8 an individual solder ball therewithin and in registered alignment with an
9 associated bond pad on the substrate;

10 laser-bonding the solder balls to their individual bond pad; and

11 after the laser bonding, removing the frame from proximity with
12 the substrate.

13
14 24. The method of claim 23, wherein said inserting comprises
15 inserting said balls from over the frame.

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17 25. The method of claim 23, wherein said laser-bonding
18 comprises moving a laser beam relative to and between individual solder
19 balls.

20
21 26. The method of claim 23, wherein said laser-bonding
22 comprises moving individual solder balls relative to a generally-fixed
23 laser beam.

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1 27. A method of bonding a solder ball to a bond pad on a
2 substrate comprising:

3 providing a frame having a hole;

4 providing a solder ball having an outer surface;

5 retaining the solder ball within the hole in an ambient processing
6 environment which is generally uniform over the entirety of the ball's
7 outer surface; and

8 while the solder ball is within the hole, bonding the solder ball
9 with an associated bond pad on a substrate.

10
11 28. The method of claim 27, wherein the retaining of the solder
12 ball comprises retaining at least a majority portion of said ball within
13 the hole.

14
15 29. The method of claim 27 further comprising inserting the ball
16 into the hole from a position within said ambient processing
17 environment.

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19 30. The method of claim 27, wherein the bonding of the solder
20 ball comprises laser bonding said ball.

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1 31. A method of bonding solder balls to bond pads on a
2 substrate comprising:

3 providing a surface having a plurality of holes therein;
4 providing a plurality of solder balls over the surface;
5 depositing some of the solder balls into at least some of the
6 holes; and

7 bonding the solder balls which were deposited into the holes to
8 individual associated bond pads positioned on a substrate proximate the
9 holes.

10
11 32. The method of claim 31, wherein the providing of the
12 solder balls comprises rolling at least one ball over the surface and into
13 a hole.

14
15 33. The method of claim 31, wherein the providing of the
16 solder balls comprises rolling a plurality of balls over the surface and
17 into individual respective holes.

18
19 34. The method of claim 31, wherein:
20 each hole is dimensioned to receive only one ball; and
21 the providing of the solder balls comprises rolling a plurality of
22 balls over the surface and into individual respective holes.
23
24

1 35. The method of claim 31 further comprising removing any
2 balls from over the surface which were not deposited into a hole.

3
4 36. The method of claim 31, wherein the bonding of the balls
5 comprises laser-bonding each ball to an individual bond pad.

6
7 37. The method of claim 31, wherein the bonding of the balls
8 comprises laser-bonding each ball to an individual bond pad by fixing
9 the position of a laser beam and moving each ball into the path of the
10 laser beam.

11
12 38. The method of claim 31, wherein the bonding of the balls
13 comprises laser-bonding each ball to an individual bond pad by moving
14 a laser beam to engage each ball.

15
16 39. A method of bonding solder balls to bond pads on a
17 substrate comprising:

18 providing a surface having a plurality of holes therein;

19 providing more solder balls than there are holes over the surface;

20 moving the plurality of balls and the surface relative to one
21 another effective to deposit one solder ball into each hole;

22 removing excess solder balls from over the surface; and

23 bonding the balls which were deposited into the holes to
24 individual bond pads positioned on a substrate proximate the holes.

1 40. The method of claim 39, wherein the bonding of the balls
2 comprises laser bonding the balls.

3
4 41. The method of claim 39, wherein the bonding of the balls
5 comprises laser bonding the balls by moving each ball into the path of
6 a laser beam.

7
8 42. A solder ball support apparatus comprising:
9 a frame; and
10 a plurality of ball-supporting features configured to maintain at
11 least two solder balls in registered alignment with at least two different
12 bond pads on a substrate.

13
14 43. The solder ball support apparatus of claim 42, wherein the
15 ball-supporting features comprise individual holes which extend through
16 the frame.

17
18 44. The solder ball support apparatus of claim 42, wherein the
19 individual holes are dimensioned to receive only one solder ball at a
20 time.